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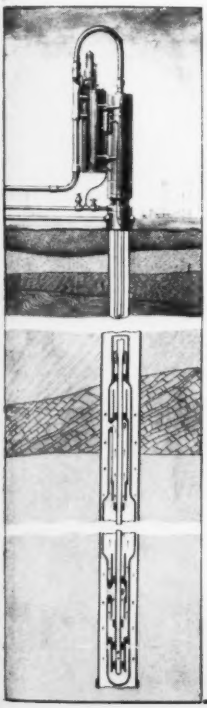

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PROJECT K.104–C

By K. G. TAIT

THE wartime pipelines, under their various names, have figured largely in the strategy and eventual success of the Allies, and although the Project K.104–C can hardly claim the distinction of being a hazardous or major project, it did serve a very useful purpose in the Middle East campaign.

OBJECT IN LAYING THE LINE

A supply of gasoline, aviation spirit and kerosine was required by the 8th Army, the people of Upper Egypt and the Sudan, and the R.A.F., together with the U.S. Air Force.

Fighter and bomber stations were supplied by tank trucks and rail car, but this source of supply was vulnerable and could be costly in case of low level attacks by the Luftwaffe. Rolling stock and tyres were at a premium and it was estimated that in some six months time the supply situation would be critical.

The Army relied on road transport for the supply of gasoline and trucked the fuel from rail heads; however, the serious rolling stock shortage was further aggravated by the dependence on the "flimsy" or four-gallon can. Supplies of plate for the cans involved either a long run round the Cape or the dangerous trip through the Mediterranean. Die stocks and spare parts for the already overworked tin factories presented a very serious "bottle-neck", and at a meeting held in G.H.Q. the whole situation was aired and methods considered to reduce lost time, cut out rolling stock and conserve tyres.

* Paper read before Trinidad Branch.

A pipeline with adequate storage facilities to utilize barge transport and distribute aviation spirit was the obvious answer.

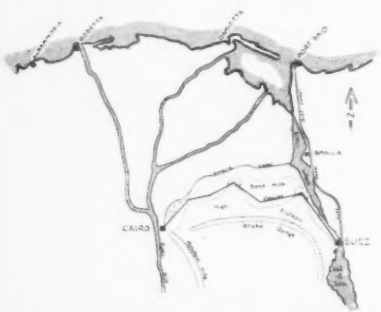
Preliminary Work

A certain amount of pipe was in stock for water lines, also some diesel driven pumps were known to be held in R.E. stores, but none of this material was readily available. After a few days of frantic signalling, information started to trickle in, and fortunately the pump capacities and pressures were made known quite early. The question of route, position, supply point, etc, was left very fluid.

Suèz, although a port subject to air attack, was on the Red Sea and therefore open to India and the refinery at Abadan. The refinery at Suez was treating indigenous crude and leading gasoline to make up aviation spirit, and being on the spot could control the supply and vary the specification at short notice. Dispersed storage was under construction at a point "A" in the desert and the starting point was thus established.

Terminal and distribution points had to be considered and the location of bomber and fighter fields settled that question, but with barge transport to consider it seemed that a point on a main waterway was the ideal.

Secrecy was of paramount importance and any new construction work would attract attention, but it might pass unobserved in an area already developed. Such a place was Ghamrah, close to the Ismailia canal and developed as an oil distribution area with small disconnected tanks owned by several marketing concerns who distributed kerosine by donkey cart. It was decided to make Ghamrah a terminal with a view to future expansion.



Snags

The tankage at Ghamrah was insufficient to stock the quantities required and supply the local market at the same time. It is obvious that for the success of the venture the donkey carts must still continue to fill and move as usual, otherwise questions would result. Recently captured were two tanks of 1,500 tons capacity, but these were in Eritrea; however, the Army delegated a crew to tear these down and get them to Egypt. This order was taken too literally; the plates arrived torn down, but in very poor condition. As so much work was required to repair the damage, it was decided to cut down a molasses tank in Alexandria and rebuild it in Ghamrah. This was done.

The route of the line was dependent on the pumping pressure and no maps were available to give any idea of the elevation of the ground. A trip over probable routes, using a prismatic compass and pocket barometer gave an idea of the general line to adopt, but on checking against the pump and line losses the hydraulic gradient cut the topographical line. Some further days were spent looking for a flatter route. Search revealed a route was possible, with appallingly difficult stretches, but the only one to permit the use of the existing equipment. With only one bench mark available, the route was surveyed to get the pipeline requirements. An 8-inch line was indicated, but 6-inch was found to be the only pipe available free from bitumen lining; 135

miles of pipe were needed, so 6-inch was adopted. This reduction in diameter increased pressure losses and it was necessary to find lower ground for about 40 miles. This was done at the expense of forsaking a good route and going into boulder "wadis" and soft sand, liable to become raging torrents with only a slight rain.

Type of Pipe and Joints

As previously stated, the only pipe available was water pipe, butt welded, plain end and light weight, meant for pressures of 250 lb or so; the calculated pressure on the line was 960 p.s.i. with gasoline, and 1025 p.s.i. with kerosine. The line had to be tested and this meant testing with saltwater so the test pressure would be 1200 p.s.i.

Some doubt was felt as to the suitability of the pipe and tests were made using Johnston couplings. The pipe was found to fail at 1350 p.s.i. by tearing along the weld; it was a small margin of safety, but still there. Rubber rings supplied were of the red water quality. These were tested and after soaking in gasoline and proving their unsuitability, "Q" made efforts to secure Neoprene rings. During the tests it was found that a coating of soft soap prevented the ring from absorbing gasoline and appeared to inhibit the tendency to soften and swell.

Johnston couplings have no mechanical strength to resist the pipe pulling out, and as temperature stresses were high, it became necessary to insulate the line as well as providing anchorage. Tests of various sorts were made, and it was found that burying the line to 3-feet depth gave a constant temperature and allowed pipe to be laid for nearly a mile with only one concrete block anchor.

Work started on the tank site at Ghamrah, underground pumping stations at point "A" and work on the line proper.

Material Deliveries

The route of the line was such that transport of pipe to the stringing line was very difficult, but this was overcome by routing pipe into points accessible by pontoon carrying vehicles. War traffic along the single line meant that stoppages to unload line had to be cut to a minimum. To add to the difficulties the trucks carrying pipe had to arrive at night and be off loaded by hand under black-out conditions. Under these circumstances it was something of a record that only one accident occurred.

Pontoon carriers were able to take but fifteen joints of pipe and only over good hard ground. As a considerable amount of the route lay over soft sand or boulder-strewn desert, a bulldozer was used to clear the track, but long sections had to be carried in by hand. The worst sector of seven miles length was carried in from a dump established either end and this work went on night and day under noon temperatures of 120 to 135° F.

Mechanical Equipment

For ditching purposes there were available two pieces Buck-eye machines, one piece Cleveland and three Bay City trench hoes, all badly worn and with no spares available. The rotary type machines had worn-out tines, and in an effort to use them we forged new teeth from old 80 lb yd rail sections and chilled the ends.

Mechanical equipment proved a failure due to the poor condition of the machines and the rock-like desert, the sand being bonded by rock salt. In all only 12 kilometres of ditch were made by machinery.

Two bulldozers and one carry-all scraper did splendid service and the ground was loosened by using an angle-type rooter drawn by a bulldozer. The ditch was cut by hand for the remainder of the way.

Methods to Ease Ditching Work

Every effort was made to get pipe laid and hooked up to a pump, and by this time some 20 miles of pipe were in place. A shallow ditch was scooped out of the hard desert and water pumped along the line already laid. Water was allowed to flow down the ditch until stopped by rising ground. This partly dissolved the salt bonding and made the work easier. In rocky parts, holes were drifted into the soft rock and gelignite set in and exploded, the shattered spoil being excavated by hand. In all some 9½ miles of rock were blasted out, all the work being done at night.

General Job Organization

Work was arranged to start at four points, i.e., terminal, pumphouse, and two points equidistant.

Personnel for the work was limited, consisting of two persons. As it was impossible to keep work going under these conditions, help was requisitioned and two men were flown from Venezuela, but dysentery and malaria only gave three people on the job at any one time and usually only two. Attached for the work were two R.E. Officers and 53 O.R., but they were only for the purpose of ration supplies, machine operation, signals, etc, and for clerical work.

Labour was Saidi from Upper Egypt, and the maximum number on all sections 1300.

Gangs were made up of twenty-five men and a "Rais", and worked on ditching and pipe-laying, asphalting, testing, concrete work, etc.

Some fifteen miles of pipe had to be laid within city limits and this was all welded. The outskirts of the city are agricultural lands and irrigated by a multitude of canals. Each canal crossing was protected by 8-inch pipe sleeves, and some of these waterways are 50-feet across. Such places were bridged using an all-welded pipe truss braced with wire line. The best type was found to be a modified Warren truss with an extended queen post to tension the wire line.

Riveting of the tanks at the terminal was all hand work as air tools could not be supplied, but the work was of a very high quality and very little trouble experienced despite the severe handling of the plates as previously mentioned.

Tanks

The roof and bottom plates were so badly damaged that re-riveting was out of the question, and so all lands were cut off and sketch plates made to fit the whole, then butt welded and lowered on to a "mix-in-place" foundation circled with dressed limestone.

Roof work and trusses had to be patched, and the trusses were so poor that it was found expedient to put in a cross spider of welded pipe and support the same on pipe columns.

To repeat the difficulties of the work and supervision which extended over 135 miles of rough desert, would be boring, but the greatest difficulty encountered was dysentery.

General Management

It was realized that to maintain efficient operation the line must be put into a good condition and maintained as such; go-devil connexions were made at every 15 miles. However, with the line buried a stuck go-devil was a serious hazard and as such a thing as a go-devil could not be had, one was made with a fluid actuated rattle. This consisted of a box attachment and a fan-like blade with weighted arms; if the go-devil stuck, the flow past the piston allowed a higher velocity and actuated the blades throwing out the rattle arms and rapping the cage. Experimental points proved this was easily located by a microphone and head-phones. Fortunately it had to be found once only.

In addition, pipeline inhibitor was injected at the station and helped to keep the line in good condition.

Testing and Switching of Product

The line had to carry aviation spirit, M.T. benzine, gasoline, and kerosine, and so it was necessary to segregate the products at the terminal or switch them into the various receiving stations. A test point was made by making a loop of 350 feet of 6-inch pipe before entering the receiving tank, provision being made to switch to a slops tank. Time of arrival at the loop was calculated from pumping speeds and samples taken tested for gravity and for colour against standard colours in a light box. The results were checked in time to switch the product to the slops tank and get a clean "cut". Fifty barrels was all that was contaminated in the journey, and this was brought up to standard octane rating by switching aviation spirit into the slops tank as required. This mixed fuel was used for local transport only in case the product was not up to grade when the slop tank was nearly full.

Preliminary Tests

When the line was completed salt-water was pumped in and block valves closed until pressure was 1200 p.s.i. The section was then walked and any leaks made good. This continued until the whole line was under pressure of 1200 lb. nominal, the pressure varying due to the elevation, but all the line having been subjected to maximum pressure.

Water was released at the terminal but the pumps kept going; when full bore flow was established the terminal valves were closed as rapidly as possible in order to throw a water hammer into the line.

Forty-two joints of pipe burst along the weld and two swelled to 8-inch diameter and cracked as a result of this test. Repairs were made and the test repeated. Two joints of pipe burst and fifteen rubber gaskets blew out. The third test withstood the load and this was repeated twice again, each time with no ill effects.

The valve was opened and water pumped through to flush the line; this water was piped into the Ismailia canal. The go-devil was entered and pumped 64 miles before it stuck, when it was found that one of the pins had failed and let an arm curl back until it had hooked into the seat of a gate valve. This was repaired and the go-devil completed the trip into its catch basket at the terminal. Only about a barrel full of scale, stones and pieces of wood were cleared from the line, which proved that our policy of closing the line each night had paid dividends.

Finale

The first cargo of kerosine was pumped through and displaced the water which was switched into the canal. The idea of pumping kerosine first was to free any rust bound scale before shipping gasoline. Pockets of water continued to come in slugs for three to four hours and the kerosine was slightly off colour but tested up to flash point and illuminating properties. Sediment was allowed to settle and the first pumping totalled 3000 tons of kerosene. This was followed by M.T. benzine to get practice at cutting and switching; 1000 tons was pumped on this consignment. Aviation spirit came next, and the line was in full operation with very satisfactory results. Sixty tons per hour was maintained at 960 p.s.i. pressure. Later a booster station increased the flow to 83 tons per hour.

When the author left Egypt the line had operated for nearly two years and had only given slight trouble on two occasions, due to gaskets softening and pushing out beyond the neck ring.

COUNCIL COMMENTARY

THE first meeting of Council in 1948 was held at Manson House on January 14 with good attendance. Minutes which had been circulated were passed as read, although ten items required further consideration. These concerned the dates of the Annual General Meeting fixed for April 14, and the President's address fixed tentatively for April 30, the form of ballot paper which was approved, and the form for nomination which was approved.

Among new items were the launching of the London Branch, the reports of committees dealing with Publications, Branches, and aviation products data, and the tabling of information concerning nominations to Council and the closing date of the ballot. Last, but not least, two reports were tabled dealing with the all-important matter of the forward policy of the Institute with regard to public relations and finance generally, tabled and discussed but not by any means fully dealt with as they had not been circulated previously.

The report of the Branches Committee also contained quite a large number of suggestions and views relevant to the financial situation and was accepted as helpful. Attention was drawn to the need for increased membership, to the possibility of increases in the price of publications to non-members, to the possibility of altered methods of distribution of publications such as "Standard Methods", and, in general, extended publicity in the best sense which included, but was not exclusively confined to, the prospect of making publications more profitable.

Matters raised from the Publications Committee included the make-up of the *I.P. Review*, and the progressive activities of the Library Sub-Committee. Next followed a discussion on the control of expenditure and the desirability of ensuring that spending should not be restricted without due regard to the importance of making certain expenditures at particular times.

General effect of these discussions will be to maintain a lively interest on the part of each committee in good budget estimating and the need for justifying any proposed expenditure if it is to escape the threatening axe which may be wielded by Finance Committee on any ill thought-out or inadequately supported proposals.

Whatever else Council meetings may be they are never, nowadays, any kind of boring formality and there is reasonable hope that from all this discussion and activity, a better, more widely representative and more useful Institute of Petroleum will finally emerge.

INTERNATIONAL RHEOLOGICAL CONGRESS

Upon the initiative of the British Rheologists' Club an International Congress on Rheology is being organized in Holland, the probable dates being September 21–24, 1948, and longer if necessary. The subjects will cover (*a*) theoretical and fundamental experimental problems; (*b*) industrial applications; (*c*) biological problems. Persons intending to present papers should communicate with Dr R. Houwink, Julianalaan 134, Delft, Holland.

Anglo-Iranian Oil Co. announce the provisional total for the production of crude oil in Iran during 1947 as 20,000,000 tons. Production from the company's fields in the United Kingdom during 1947 is given provisionally as 47,000 tons.

BRITAIN'S OIL SUPPLIES

SPEAKING at a recent press conference, the Parliamentary Secretary to the Ministry of Fuel & Power said that the main difficulty in obtaining oil supplies for Britain lay in the difficulty in finding tanker tonnage. World demand for oil had increased, due to a considerable extent to conversion from coal to oil-burning throughout the world.

In 1946 the British Commonwealth produced only about 3½ million tons (excluding Canada's 1 million tons) of oil. British companies have built up a production of about 50 million tons per year in foreign countries, but a substantial part of the costs has to be paid in gold or in currencies convertible into dollars. "British" or "sterling" oil is insufficient to meet in full the requirements of British companies throughout the world, estimated at 58 million tons in 1948, a balance of 7 million tons having to be bought from American companies and paid for in dollars.

Schemes for increasing the amount of "British" oil available and eventually to double its output involve not only the development of oil production but also the erection of refineries in Britain and elsewhere.

TANKER SHORTAGE

The immediate problem, said Mr Robens, is to find the required tanker tonnage. Pre-war Britain owned 4.5 million deadweight tons of oil tankers, or about 28 per cent of the world's total. Although the British tanker fleet has been built back to its pre-war level it is only 20 per cent of the world's total. American tankers account for 52 per cent of present world tonnage, compared with 26 per cent before the war.

After the end of the war the U.S. Maritime Commission laid up about 300 tankers, but 150 have now been reactivated. Of these latter the British companies have been able to purchase fifty, but are still short of their needs.

COAL/OIL CONVERSIONS

Immediate economies in Britain's oil consumption must be made. The amount of gas oil used in the production of carburetted water gas must be reduced by 50,000 tons by the carbonization of a further 400,000 tons of coal during the remainder of the winter.

Out of a total of 2,523 industrial coal/oil conversion schemes authorized, 1,277 have been completed and are burning oil at the rate of 2,200,000 tons per annum. There is a danger that it might not be possible to meet all demands for fuel oil if the schemes are allowed to proceed as originally planned. All firms who had not completed their conversions were, therefore, being asked to report the stage they had reached in order that a programme for bringing the schemes into operation could be drawn up.

GERMAN OIL AND GAS OUTPUT

Crude oil production in Germany during 1947 totalled 576,617 metric tons, a decrease of 73,104 metric tons or 11.9 per cent from the 1946 total of 649,711 metric tons. Output from various areas was:

	1947	1946
	Metric tons	
Schleswig Hölstein-Hamburg	92,645	111,303
Hannover	363,630	451,897
Emsland	114,067	79,729
Baden	6,275	6,782
Total	576,617	649,711

In 1947 total output of natural gas amounted to 77,744,000 cu.m., compared with 114,807,000 cu.m. in 1946. The greater proportion of this—71,621,000 cu.m. in 1947, and 106,372,000 cu.m. in 1946—came from the Bentheim gas field. The remainder was produced in various oilfields.

DEVELOPMENTS IN TECHNIQUE IN FUELS AND LUBRICANTS*

By J. A. ORIEL, C.B.E., M.C. (Fellow)

THE period of nearly 100 years since the birth of the oil industry has been one of rapid development in many fields. Advances in other industries have had important effects on the relative demands for the various products obtainable from petroleum, and also on the quality of the individual products. The major developments in the petroleum industry have taken place during the last fifty years, proceeding at an ever increasing pace, the advances during the last ten years being greater than in any previous decade. I thought, therefore, that you might be interested to hear something of recent developments in technique in the petroleum industry, with particular reference to fuels and lubricants. In dealing with the former I shall devote my attention particularly to fuels for internal combustion engines, since it is in this field that the developments of greatest interest have occurred.

In the early days of the petroleum industry the major product was kerosine for illuminating purposes. This was produced by simple distillation, without any high degree of fractionating efficiency. By the first part of this century the picture was beginning to change. With the advent of the internal combustion engine the need switched over from kerosine to petrol. The value of the latter was judged by the ease with which it could be carburetted and thus a low specific gravity came to be considered the hallmark of a satisfactory fuel. Petrols quite satisfactory for the engines of those days were obtained by simple modifications to the distilling plants used for the manufacture of kerosine. These distillation processes gave, on the average, about 20 to 25 per cent of petrol, some 10 per cent of kerosine, and a residue.

In those days there was also some production of lubricating oil from petroleum, but the crude oil had to be carefully chosen and in the main Pennsylvanian crude oils were the only ones which could be refined to yield a reasonable grade of lubricating oil.

This was roughly the picture up to 1914. During the First World War, when research was as usual given an impetus, Ricardo and others carried out a series of researches into the knocking or detonation tendency of petrols. Ricardo designed a variable compresson engine which enabled this tendency to be accurately measured, and was thus able to demonstrate the relation of the fuel to detonation. It was found that of the hydrocarbons present in petroleum, aromatics gave the highest useful compression ratios. This completely reversed all previous ideas on the quality of petrol, in that it was the petrol of the *highest* specific gravity which had the least tendency to knock.

This work of Ricardo's encouraged scientific research into the whole question of the relationship between the petrols used and the engines being built to use them. During the same period the aero-engine was being developed very rapidly and the need for a suitable aviation petrol was becoming evident. The subsequent course of development of aviation engines and fuels provides an excellent example of how the reaction between two industries can result in technical advances of the highest importance.

The rapid expansion in the use of the internal combustion engine was now

* Paper read before XIth International Congress of Pure and Applied Chemistry, London, July 17–24, 1947.

making it abundantly clear that in order to meet the world's demands it would be necessary to readjust the percentage of the various products present in petroleum. This demand encouraged the investigation of the cracking process, which was actively pursued from, say, 1910 to 1920, and at the end of that period there were three or four reasonably good processes available for the cracking of heavy hydrocarbons into the lighter materials.

The thermal cracking process is so well known that there is hardly any need for me to go into the matter very deeply, as it merely consists in subjecting heavy distillates, such as gas oil or residues to temperatures of the order of 500 C under medium pressures of 400 to 1000 p.s.i. Several types of reactions occur in simple thermal cracking of this type. Molecular fission produces olefins and paraffins of lower molecular weight from high molecular weight paraffins, *cyclo*-paraffins are dehydrogenated to aromatics, long side chains are split off from aromatic nuclei giving olefins and aromatics of lower molecular weight. The gas produced in the cracking process contains hydrogen, methane, ethane, ethylene, propane, propylene, and a certain amount of butane and butylene. There is also some polymerization, and ultimately, if reaction time is sufficient, petroleum coke is formed. The earlier thermal cracking units were provided with so-called "reaction chambers" in which the coke was collected, and it was necessary to shut the plant down at intervals, the coke being removed from the "reaction chambers" by rather laborious methods.

A subsequent development of thermal cracking was the reforming process, in which straight-run gasoline is used as the charging stock. The main reactions involved in this case are the dehydrogenation of paraffins and *cyclo*-paraffins to olefins and aromatics respectively, though some molecular fission and polymerization also occurs. The olefins are of higher anti-knock value than the paraffins from which they are formed and this more than offsets the slight loss of gasoline due to the gas produced.

Lubricating Oils

I would now like to deal with some important developments in the manufacture of lubricating oils, partly to observe the chronological sequence, but partly because the subsequent development of fuel technology will lead us to consider the future, and it is with a glimpse into the future that I want to end my talk.

I have already said that in the earlier days Pennsylvanian crude was looked upon as the only really suitable source of good lubricating oil. The reason for this was that Pennsylvanian crude is practically free from asphalt and is easily refined to give lubricating oils of relatively light colour; the more abundant asphaltic base crudes require much more intensive refining, particularly in the case of the viscous residual oils used for the lubrication of steam engine cylinders, etc. It was quite natural that one should inquire as to the possibilities of obtaining similar lubricating oil fractions from other crudes, and in order to follow the extraction a little, one has to go back to about 1909, when Edeleanu developed, for quite other purposes, his process for the extraction of aromatics from kerosine. In those days, when kerosine, as I have said, was the most valued product, the presence of aromatics in the kerosine fraction was naturally a source of smoke when burned in a wick lamp. The process consists simply in agitating the kerosine with liquid SO_2, when the aromatics dissolve in the SO_2 and the paraffins remain practically undissolved. The SO_2 is then recovered and you are then left with an almost entirely paraffinic kerosine.

The same methods were applied to lubricating oil, except that more efficient solvents used were developed,

and during the period 1930–35 there was considerable activity in this field. Solvents such as furfural, phenol, and the two-solvent process using propane and cresylic acid were fully developed. The outstanding result of this is quite clear: that we are now no longer dependent on Pennsylvania for our supply of lubricating oil, but almost any crude in the world can be used for this purpose, the selection being based merely on the yield obtainable, which, of course, is dependent on the percentage of paraffins actually present in the lubricating oil fraction.

This, then, gives us a basic oil on which to build our lubricating oil business. For specific purposes such as electrical insulating oils, core oils, textile oils, and so on, particular processes have to be developed, and in many cases specific additives have to be used.

A large proportion of the total amount of lubricating oil produced is used in internal combustion engines, and it is in this field that one meets the greatest difficulty, owing probably to the continuous demands for engines of greater power and efficiency. Since all internal combustion engines are heat engines, the efficiency is higher, the higher the maximum temperature of the cycle. Furthermore, even the most efficient engines are able to produce power equivalent to only about one-third of the energy available from combustion of the fuel; thus about two-thirds of this energy appears as waste heat in the exhaust or transmitted through the cylinder walls to the cooling medium. On both counts therefore improvements in engines tend to increase the temperature to which the lubricating oil is subjected.

The problem of lubricating the internal combustion engine varies considerably, of course, from a diesel engine to the high-powered aircraft engine, and a considerable amount of research and development has been undertaken in order to meet the various needs.

Very active research has gone on for many years to determine just exactly what it is that the lubricant does, and to determine if possible whether any chemical or group of chemicals is the ideal lubricant. Whether this lubricant is a petroleum hydrocarbon or not is immaterial: the question is to find the most suitable lubricant, and the problem has not yet been solved. It may well be that this will be the ultimate solution of many of our lubricating oil problems, but meanwhile we have to make do with the compromise of using petroleum hydrocarbons, and I would add this point: that at present, at any rate, petroleum hydrocarbons are in sufficiently plentiful supply to meet the lubrication requirements of the world, whereas some specific chemical for the purpose may not meet the needs either in quantity or—and this is quite an important point—in price. The petroleum industry, then, must devote its attention to (*a*) the improvement of the basic oil, as has already been suggested in the description of the solvent process, and (*b*) the addition of specific additives to the lubricating oil to deal with conditions in the internal combustion engine as these conditions become more stringent.

The troubles which are met are mainly due to formation of carbon in the cylinder, the formation of carbonaceous deposits behind the piston rings, causing piston ring sticking, and lacquering of the cylinder walls and of the piston itself, and finally there is always present the possibility of corrosion of bearings due to the formation of acids during the conditions of oxidation which exist in the cylinder.

Motor and Aviation Fuels

Returning now to fuel, we enter on a distinct change in the course of technological development. The early thermal cracking processes were developed empirically. Subsequently the subject

was studied in a much more scientific manner, and this has naturally led to far-reaching advances.

As I have mentioned earlier, considerable quantities of gases containing the lighter paraffins and olefins are produced as by-products in the cracking process. At the outset these gases were merely burnt, but it was soon realized that something better could be done with the reactive olefins present. The first plants for the production of *iso*-octane on a commercial scale were erected in the early 1930's; previously this hydrocarbon had only been available as a pure chemical selling for about £5 per gallon. The gases were fractionated to isolate a fraction consisting substantially of butanes and butylenes. Under the catalytic influence of cold sulphuric acid the reactive δ-butylene in this fraction polymerizes to di-*iso*butylene, a mixture of two isomers, both of which give the same *iso*octane, 2:2:4-trimethylpentane, on hydrogenation.

*Iso*octane had already been adopted as the high rating standard reference fuel for knock testing, its rating being 100 by definition. Its commercial production opened up entirely new possibilities in the manufacture of gasolines of high anti-knock value, and gave a great impetus to the manufacture of branched chain paraffins of the same type. By the use of hot sulphuric acid, or other catalysts such as phosphoric acid, it is possible to cause the δ-butylene to react with α- and β-butylenes. The di-*iso*butylenes thus formed give on hydrogenation mixtures of other branched octanes such as 2:2:3-, 2:3:4- trimethylpentane, etc. These mixed octanes rate slightly less than 100 octane number, but the yield is between two and three times that in the cold acid process.

Another method of manufacturing hydrocarbons of high anti-knock value is the alkylation process. This was originally applied in the reaction between *iso*butane and butylenes, using a sulphuric acid catalyst under appropriate conditions. The importance of this process is that a mixture of branched chain octanes is obtained directly, without the need for hydrogenation. Other catalysts, such as hydrofluoric acid are also in use, and a thermal alkylation process has been developed.

Alkylation processes have also been applied to other pairs of hydrocarbons. For example, neohexane, 2:2-dimethyl butane, has been made by thermal alkylation of *iso*butane with ethylene. During the last war considerable quantities of cumene (*iso*propyl benzene), a hydrocarbon of high octane number, were made by the alkylation of benzol with propylene.

As a result of the introduction of the processes I have described, aviation fuel now consists largely of a few specific hydrocarbons, such as octanes, alkylates, cumenes, etc. The 87-octane number fuel in use before the war was made by addition of the anti-knock additive tetraethyl lead to aviation petrol obtained by simple distillation from the crude oil. 100 octane number fuel, now in general use, gives 30 per cent more power or 10 per cent lower fuel consumption, which will give you some idea of the improved engine performance made possible by recent developments in the petroleum industry.

However, even with the use of these specially-made hydrocarbons, the quantity of high octane number aviation fuel would have been insufficient for the requirements of the war without the development of the various catalytic cracking processes.

Probably the most interesting of these is the fluid bed catalytic cracking process. It was developed in great measure to eliminate some of the inherent disadvantages in the ordinary fixed catalyst bed system. In all of these processes the main difficulty is that the catalyst very rapidly becomes coated with carbon, and the difficulty of burning off this carbon and incidentally utilizing the heat so obtained has been the major problem.

In the fluid bed method the catalyst is carried to a chamber where it is regenerated by blowing with air, and then travels back to the reaction chamber. The novel part, of course, is the fact that the catalyst flows in exactly the same way as a liquid, and this process, I am sure, can be of great use in many other catalytic processes where these conditions are necessary.

Two other important processes of this nature are the Houdry catalytic process and the so-called Thermofor or moving bed process. From the point of view of the final fuel the three processes are not very different one from another. Each has its own engineering difficulties, which to a very large extent have been overcome, and in as far as high octane fuel will be required in the future these processes are being developed and will be the main source of high octane fuel.

Gas Turbine Fuels

I have just said "in as far as high octane fuels will be required in the future", and this brings me to the closing phase of my talk. The advent of the internal combustion turbine, or the jet engine, is going to force considerable alterations in refining processes. The fuel requirements of gas turbines are so different from those of the internal combustion engine that we shall most certainly have to take fresh stock of the fuel position. For twenty-five years we have concentrated on making lighter and lighter fuels with higher and higher octane number. The need for carburation and high volatility does not exist in the case of the internal combustion turbine, and as far as we know at present nothing comparable with the octane requirement of the internal combustion engine exists in the case of the turbine. This, of course, is not to say that in the future the requirements will not be narrowed down until life becomes just as unbearable in the oil industry as it is to-day, but for the moment at any rate the specifications for a turbine fuel are fairly wide. I would, however, like to add a note that as far as the road automobile is concerned, there is very little likelihood of its being turned over to the gas turbine for ten or even twenty years.

What then is the requirement of the gas turbine? There are two entirely different criteria. The first is that of the aero engine, which requires lightness, reliability and safety. From a lightness point of view the simple combustion chamber which is used for burning fuel for a gas turbine is many times lighter than the equivalent equipment required for the same horse-power internal combustion engine. Reliability is possibly one of the points where the specifications for a gas turbine fuel will be tightened up in the near future. Obviously the formation of coke in the combustion chamber is the most serious drawback, as there could be no question in an aeroplane of shutting down to decoke the chamber. This, to my mind, will probably tend towards the use of more and more paraffinic materials. The petroleum refiner will no longer be willing to have as aromatic a material as possible, but will be looking for a possible means of turning aromatics into paraffins.

The ability of the gas turbine to burn fuels less volatile than gasoline has focused attention on the safety aspect. In aircraft carriers the presence of large quantities of highly inflammable fuel in the ship's tanks is an obvious source of danger, and for this purpose fuels of relatively low vapour pressure and high flash-point will probably be specified. As regards land-based aircraft, however, the position at the moment is not quite so clear, since two conflicting influences are at work, and the available data on fires resulting from aircraft crashes does not at the moment allow a clear assessment of their relative importance. On the one hand ignition by a spark or flame of fuel escaping from a broken

fuel line or tank will obviously be less likely with a low vapour pressure fuel, and the rate of spread of flame will also be less, thus giving greater opportunity for the occupants of the aircraft to escape. On the other hand, ignition by contact with a hot surface, such as a combustion chamber or turbine blade, occurs more readily with fuels of higher flash-point, since the spontaneous ignition temperature of hydrocarbons decreases with increase in molecular weight. The relative importance of these two factors, ignition by a spark or flame and spontaneous ignition, will obviously depend on the circumstances existing at the time of the crash.

At the moment supply considerations indicate the desirability of specifying aero gas turbine fuels with a fairly wide boiling range, say 65 C to 300 C, which would have a somewhat lower vapour pressure and higher flash-point than gasoline. It may prove that a fuel of lower vapour pressure is required, in which case the petroleum industry will be faced with a reversal of earlier trends, and will have the problem of transforming fractions of lower boiling point into those of higher boiling point, in order to keep the production of the various products in line with relative demands. There is no reason to suppose that the industry will be unequal to the challenge.

The criteria for gas turbines for land and marine purposes are somewhat different, in that lightness is not of paramount importance, nor is the element of reliability as great as it is in the case of the aero engine. Even at sea one would have several gas turbines in one ship, and it would be possible to shut down and overhaul one engine whilst keeping the others going. These engines will call for as high a calorific value as possible, possibly as low a flame temperature as possible, and freedom from ash or any other material which is likely to affect the turbine blades. Its main competitor is the diesel engine, and in order to compete successfully with the diesel engine it will have to consume a fuel which is cheap enough to make up for the difference in thermal efficiency between the two types.

UNITED STATES PETROLEUM REQUIREMENTS

Estimates prepared by the U.S. Bureau of Mines of the demand for crude petroleum during 1948 show a total of 2,242.1 million barrels compared with the latest estimate of 2,137.3 million barrels for 1947. For refined products the corresponding figures are 2,234 million barrels for 1948 against 2,132.5 for 1947. Some details given in the Bureau's Monthly Petroleum Forecast No. MFR 148 are:

	1947		1948	
	Million barrels			
Production:				
Crude	1,849.9		1,936.2	
Other oils	130.4	1,980.3	139.1	2,075.3
Imports:				
Crude	97.7		100.8	
Refined	59.3	157.0	66.0	166.8
Total supply		2,137.3		2,242.1
Domestic demand:				
Motor fuel	790.0		840.0	
Kerosine	101.0		110.0	
Distillate fuel	290.0		328.0	
Residual fuel	513.0		517.0	
All other	275.5	1,969.5	290.0	2,085.0
Exports:				
Crude	45.5		50.0	
Refined	117.5	163.0	99.0	149.0
Total demand		2,132.5		2,234.0

Leaflets recently issued by Petromor Ltd., deal with **Petroleum Aromatic Extracts for Core Oils** and **Petroleum Aromatic Extracts for Paint Formulation**. Both are available in English or French from the company's Public Relations Dept., 10 Dover Street, London, W.1. A leaflet on the company's **Petrosol 33** degreasing agent is also available.

OIL FOR THE FUTURE

SPEAKING on the subject of "Oil for the Future. Does the United States Face a Shortage of Petroleum?", in November last, Joseph E. Pogue, vice-president of the Chase National Bank, told a Detroit audience that in the highly specialized activities comprising the oil industry we have a mechanism of established competence which must rank, if realistically viewed, as one of the most effective productive organisms the world has seen. Its economic and social accomplishments have been remarkable and far beyond rational expectations. There is every reason to believe that this type of enterprise can be relied upon in the future, provided its mainspring is not broken. The American economy is fortunate in having such an important responsibility lodged in tried and proven hands.

His audience, he said, was probably interested in two questions: (1) Will the supply of oil this winter fall short of requirements?; (2) Will our economy over the long term be retarded by lack of oil?

After discussing various aspects of these questions, Mr Pogue said: "So, in conclusion, let us not be misled by spot shortages this winter, the results of terrific distortions in our economy which have borne with special weight on the demands for petroleum. Nor let us be misled by the great expansion in demand that may characterize the years immediately ahead, which will both create and require an economic setting conducive to vast capital expenditures, and at times may give the appearance of inadequacies of supply. We are in the early stages of a revolution in the economies of energy which, given freedom of scope, can contribute signally to the progress of this country the U.S.A. and to the reconstruction of the world at large.

"Do we face a shortage of oil? Only if we create it out of a shortage of understanding and imagination. Only if we regulate one into existence. As a great philosopher has said: '. . . if mankind is to be enriched, to consolidate, and perfect itself, there must exist "a variety of situations." Within each nation . . . there must be a diversity of circumstances, so that when one possibility fails others remain open.' By great good fortune, the petroleum industry is a living example of this principle."

GEOPHYSICAL ABSTRACTS

The United States Geological Survey has resumed publication of the Geophysical Abstracts after a four-year interval, during which they were issued by the U.S. Bureau of Mines.

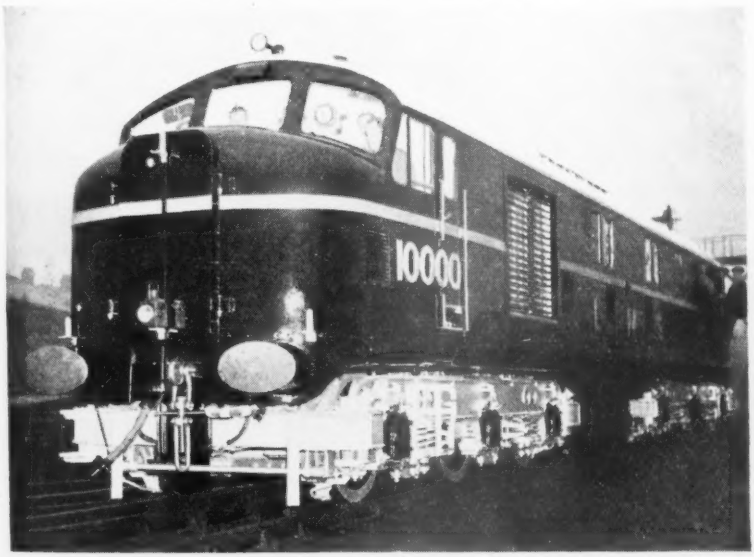
The Geophysical Abstracts are published quarterly as an aid to those engaged in geophysical research and exploration. The bulletin covers world literature on geophysics contained in periodicals, books, and patents. It deals with exploration by gravitational, magnetic, seismic, electrical, radioactive, geothermal, and geochemical methods and with underlying geophysical theory and related subjects.

Copies may be purchased singly or by annual subscription from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. For subscription, the Superintendent of Documents will accept a deposit of $5.00 in payment for subsequent issues. When this fund is near depletion the subscriber will be notified. The deposit may also be used to cover purchase of any other publication from the Superintendent of Documents. The present price of each copy of the Geophysical Abstracts is 15 cents.

[By courtesy of the Director of the Science Museum, South Kensington

THEN AND NOW

The Glasgow and Garnkirk Railway was opened in 1831 and, as seen in the above copy of an engraving in the Science Museum, London, was the occasion of much rejoicing. The latest development in British railway traction is shown below. It is the diesel-electric locomotive, No. 10000 recently put into service by the London Midland Region of British Railways. Primary power is provided by an English Electric 16-cylinder supercharged diesel engine running at 750 r.p.m. This engine is direct coupled to a 1080 kW. generator which supplies current to six geared electric traction motors of 260 h.p. fitted one to each of the axles in the two six-wheeled bogies. Fuel carried is sufficient for the return journey between London and Glasgow.



[By courtesy of British Railways, London Midland Region

U.K. PETROLEUM TRADE IN 1947

By GEORGE SELL (Fellow)

DURING the year 1947 the total imports of crude petroleum and refined products into the United Kingdom amounted to 3,477,118,000 gallons according to the preliminary figures.* This is a decline of 320,110,000 gallons, or 9·4 per cent, from the 1946 total of 3,797,228,000 gallons. This reduction is mainly in respect of refined products, as crude oil imports increased by 15·1 per cent. Details from the official return are given in Table I and show that motor spirit was the only refined product to be imported in larger quantities than in 1946, the increase being 0·4 per cent. The decreases in refined product imports amounted to 18·6 per cent for kerosine, 4·5 per cent for lubricating oil, 13·4 per cent for gas oil, and 24·5 per cent for fuel and diesel oils.

In spite of the decline in quantity of imports the total value at £85,782,975 was 11·5 per cent, or £8,874,580, higher than in 1946. In Table II the c.i.f. values have been calculated on a unit basis, the units being those used in the official return. From this table it will be seen that the values of all products were considerably higher than in the previous year. The only exception to this generalization is that asphalts and bitumens were slightly less expensive in 1947 in comparison with 1946.

CONSIGNING COUNTRIES

Such details as are available in regard to consigning countries are given in Table III, and it must be pointed out that a "consigning" country is not

* "Accounts relating to Trade and Navigation of the United Kingdom, December 1947." H.M.S.O.

TABLE I

QUANTITY AND VALUE OF U.K. PETROLEUM IMPORTS

	1947		1946		1938	
	Quantity 1000 *gal.*	*Value* £	*Quantity* 1000 *gal.*	*Value* £	*Quantity* 1000 *gal.*	*Value* £
Crude petroleum ..	618,590	13,232,436	537,602	9,661,119	567,953	5,177,532
Motor spirit	1,206,928	38,708,335	1,202,601	30,968,060	1,456,667	24,764,928
Other spirit	23,986	867,297	29,780	864,184	18,097	310,582
Kerosine	326,849	9,564,679	401,427	9,262,872	206,362	3,004,476
Lubricating oil ..	84,986	6,770,490	88,974	5,253,915	108,198	3,953,811
Gas oil	424,463	11,588,012	489,451	10,619,015	157,926	2,125,615
Fuel and diesel oils ..	791,300	18,277,630	1,047,392	19,940,056	687,346	6,570,470
Other sorts	16	6,532	1	293	956	72,783
Total refined products	2,858,528	£85,782,975	3,259,626	£76,908,395	2,635,552	£40,802,665
	Cwt.		*Cwt.*		*Cwt.*	
Paraffin wax	780,296	2,359,042	662,993	1,359,715	809,749	635,036
Mineral jelly ..	196,220	338,184	128,559	197,766	136,378	155,731
Carbon black from natural gas ..	757,086	2,181,849	652,576	1,684,712	386,208	512,754
	Tons		*Tons*		*Tons*	
Natural asphalt and bitumen	30,855	352,136	26,919	315,744	79,164	290,944
Manufactured bituminous asphalt and emulsions ..	1,084	26,770	463	12,236	52,055	275,536

necessarily the country of origin of the material concerned. It is unfortunate also that such large quantities are listed under "Other British" and "Other Foreign." It is gratifying to record that the imports from British countries amounted to 13·9 per cent of the aggregate in 1947 as compared with 10·1 per cent in 1946. It is also noteworthy that the only countries shown as having increased their oil exports to the U.K. in 1947 are Palestine, "Other British", Peru, and "other foreign", while Russia appeared in the return for the first time since the war.

Re-exports

The total quantity of imported oils re-exported in 1947 was 91,859,000 gallons, an increase of 33·9 per cent. As shown in Table IV the corresponding value was 23·5 per cent higher. Bunker fuel shipped for the use of steamers engaged in the foreign trade (including fishing vessels) were higher in quantity by 14·8 per cent.

TABLE II

AVERAGE VALUES OF U.K. PETROLEUM IMPORTS

	1947	1946	1938
	£ *per* 1000 *gal.*		
Crude petroleum ..	21·39	17·97	9·12
Motor spirit ..	32·07	25·75	17·00
Other spirit ..	36·16	29·02	17·16
Kerosine ..	29·26	23·07	14·56
Lubricating oil ..	79·67	59·05	35·54
Gas oil	27·30	21·70	13·46
Fuel and diesel oils	23·10	19·04	9·56
Other sorts ..	408·25	293·00	76·13
Total refined products	30·01	23·60	15·48
	£ *per cwt.*		
Paraffin wax ..	3·02	2·05	0·78
Mineral jelly ..	1·72	1·54	1·14
Carbon black ..	2·88	2·58	1·33
	£ *per cwt.*		
Natural asphalt and bitumen ..	11·41	11·73	3·68
Manufactured bituminous asphalt and emulsions	24·70	26·43	5·29

TABLE III

COUNTRIES CONSIGNING PETROLEUM TO THE U.K.

Country and Product	1947	1946	1938
	Thousand gallons		
BRITISH WEST INDIES:			
Motor spirit ..	104,789	101,137	90,607
Kerosine ..	58,167	93,153	—
Fuel & diesel oils	73,736	56,312	118,136
	236,692	250,602	208,743
PALESTINE:			
Motor spirit ..	25,283	19,242	—
OTHER BRITISH:			
Crude petroleum	43,897	14	20,390
Motor spirit ..	33,314	27,494	8,022
Kerosine ..	22,058	8,868	2,854
Lubricating oil ..	109	259	79
Gas oil	25,546	12,939	12,039
Fuel & diesel oils	11,707	9,641	1,197
	136,631	59,215	44,581
NETH. WEST INDIES:			
Crude petroleum	220,543	229,240	160,782
Motor spirit ..	414,818	332,663	589,531
Kerosine ..	140,032	92,821	50,892
Lubricating oil ..	18,544	25,418	—
Gas oil	85,235	72,826	21,936
Fuel & diesel oils	370,010	512,341	251,290
	1,249,182	1,265,309	1,074,431
UNITED STATES:			
Crude petroleum	10,847	45,035	14,995
Motor spirit ..	488,386	381,506	314,497
Kerosine ..	51,554	114,451	57,800
Lubricating oil ..	66,073	63,255	85,660
Gas oil	241,292	346,578	39,404
Fuel & diesel oils	31,963	107,358	63,312
	890,115	1,058,183	575,668
IRAN:			
Crude petroleum	158,168	80,997	54,221
Motor spirit ..	68,759	303,240	314,066
Kerosine ..	50,104	85,190	59,884
Gas oil ..	20,639	13,133	37,093
Fuel & diesel oils	283,432	328,082	161,365
	581,102	810,642	626,629
VENEZUELA:			
Crude petroleum	101,033	139,847	138,975
Motor spirit ..	37,602	29,199	—
Fuel & diesel oils	12,177	25,819	13,860
	150,812	194,865	152,835
PERU:			
Crude petroleum	23,325	14,858	21,865
IRAQ:			
Crude petroleum	—	8	141,796
SOVIET UNION:			
Motor spirit ..	12,838	—	47,460
Lubricating oil ..	—	—	13,360
	12,838	—	60,820
NETH. EAST INDIES:			
Motor spirit ..	—	—	23,854
OTHER FOREIGN:			
Crude petroleum	60,777	27,603	14,929
Motor spirit ..	21,139	8,120	68,630
Kerosine ..	4,934	6,944	34,932
Lubricating oil ..	260	42	9,099
Gas oil	51,751	43,975	47,454
Fuel & diesel oils	8,275	7,839	78,186
	147,136	94,523	253,230

Exports

Details of the exports of petroleum products produced or manufactured in the United Kingdom are given in Table V. From the figures it will be noted that, while the quantity increased by 91·3 per cent, the value advanced by 32 per cent only. Average values of the individual products in £ per 1000 gal are: motor spirit, £36·19; kerosine, £31·80; lubricating oil, £126·07; gas oil, £25·19; fuel and diesel oils, £22·71.

TABLE IV

U.K. RE-EXPORTS OF IMPORTED PETROLEUM

	1947	1946	1938
	Thousand gallons		
Motor spirit ..	40,600	44,572	14,075
Kerosine ..	3,373	5,427	2,832
Lubricating oil ..	3,832	6,177	4,344
Fuel & diesel oils	40,165	3,922	4,284
All other sorts ..	3,859	8,504	3,596
	91,859	68,602	29,131
Value ..	£3,109,668	£2,517,109	£800,496
Oil fuel for use in steamers ..	461,636	402,283	313,204

TABLE V

U.K. EXPORTS OF HOME-PRODUCED AND MANUFACTURED PETROLEUM

	1947		1946		1938	
	Quantity 1000 *gal.*	*Value* £	*Quantity* 1000 *gal.*	*Value* £	*Quantity* 1000 *gal.*	*Value* £
Motor spirit	23,502	850,569	1,881	66,846	54,982	884,969
Kerosine	1,106	35,167	137	5,027	12,114	186,358
Lubricating oil ..	28,493	3,592,224	33,092	3,566,027	17,466	1,161,520
Gas oil	11,730	295,478	2,191	47,153	29,129	384,434
Fuel and disel oils ..	10,920	247,974	343	7,241	17,200	178,341
All other sorts ..	1,085	131,739	2,517	211,618	2,790	58,315
Total	76,836	£5,153,151	40,161	£3,903,912	133,681	£2,853,937
	Cwt.		*Cwt.*		*Cwt.*	
Lubricating compounds	95,737	315,820	110,642	284,113	605,265	714,364
Paraffin wax	70,720	274,028	11,546	35,817	88,016	75,911
Manufactured bituminous asphalt and emulsions ..	*Tons* 47,380	588,707	*Tons* 109,854	1,042,427	*Tons* 91,928	426,059

PERSONAL NOTES

Jas. S. Parker, F.Inst.Pet., manager of the Ellesmere Port refinery of Lobitos Oilfields Ltd., has recently left England on a visit to Trinidad, Curacao, Amba, Columbia, Peru, and Ecuador.

H. G. Williams, M.Inst.Pet., until recently field manager, chief engineer, and production superintendent in Trinidad for the National Mining Corpn. Ltd., has now returned to England.

H. A. Holmes has been appointed chairman of the Board of London & Thames Haven Oil Wharves Ltd., in succession to Lord Latham.

It is with regret that we record the death on January 26 of *Robert Irving Watson*. It was only on December 31 that he resigned from the chairmanship of The Burmah Oil Company Ltd., a position which he had held since 1943. His association with that company dates from its registration in 1902, when he was in the petroleum department of Messrs. Findlay, Fleming & Co., who were appointed agents for the company. In 1912 Mr Watson joined the London staff of the company, in 1918 was appointed to the London Board, and in 1920 became managing director. He had also been a director of many other oil companies, including the Anglo-Iranian Oil Co. Ltd., and Shell Transport & Trading Co. Ltd.

Commander *R. E. Stokes Rees*, one-time secretary of the Institute, was a welcome visitor to the office recently. He is still the same "Stoker" and as full of energy as ever. To his many friends in the Institute he sends his "Chin-Chin."

PETROLEUM IN PARLIAMENT

Benzole Production

The Minister of Fuel & Power stated on January 22 that the production of benzole from the gas and coke oven industry during 1943 was 54 million gallons. In 1947 it was 44 million gallons, and some increase is expected in 1948 from the additional amount of coal to be carbonized at coke ovens. Owing to the shortage of carbonizing capacity the scope for increased recovery of benzole at gas works is extremely limited.

The Petroleum Board

Asked if he proposed to abolish Pool petrol shortly, and if he would make a statement on the future of the Petroleum Board, the Minister said (January 22): The distribution of a standard grade of petrol must continue while the Petroleum Board remains in existence. Arrangements thereafter must depend on the circumstances prevailing at the date of its dissolution—which has not yet been settled.

Hydrocarbon Oils Duty

Asked (January 27) whether he was aware of the dissatisfaction existing amongst many industries at the increasing cost of light hydrocarbon oils used for industrial purposes and whether he would consider reducing or eliminating the duty on these, the Chancellor of the Exchequer in a written reply said: "The Hon. Member may rest assured that in preparing my Budget I shall try to bear all relevant considerations in mind."

American Oil Purchases

On January 29 the Minister of Fuel & Power was asked whether oil sold by Anglo-Persian and North Borneo Companies to American firms was paid for in sterling or dollars; and, if payment was in dollars, what was the sum involved. He replied that payment was sometimes made in sterling and sometimes in dollars. He had no information regarding dollar receipts from these transactions.

Coal Oil Conversion

Adequate supplies of fuel oil should be available during the next six months for plants which have already been converted to oil firing, said the Minister in a written reply on January 29. He added that he was not aware that tank storage facilities were giving rise to difficulties.

Laid-up Tankers

The Minister of Transport, asked the size and number of tankers laid up or tied up at Falmouth, said in a written reply on January 29: "Two, apart from ten tankers undergoing mainly short term repairs: the *Desmoulea*, of 8146 gross tons, which is heavily damaged and is being prepared for dry-dock, and the *Empire Control*, of 5612 gross tons, built in 1913. Until recently she was reserved for conversion into a herring factory, but it has now been decided not to proceed with this and she is being offered for sale."

Charter Tankers

On January 30 the Minister of Transport was asked how many ships of 2000 tons and over were still requisitioned by his Department; and of these, what is the tanker tonnage immediately available; how much tanker tonnage is on charter; and what is the capacity of oil and spirit represented by these figures. He replied in writing: "On January 22, 1948, 51 ships of 2000 gross registered tons and over, including 23 now in process of reconditioning. No tankers are under requisition. Foreign flag tanker tonnage on charter to British

interests at the same date amounted to 89 ships, totalling 1.16 million deadweight tons. None of these is on charter to H.M. Government. Carrying capacity varies according to the area of employment. They would carry to the U.K. in one year approximately 7.7 million tons of oil from the Netherlands West Indies or 5.2 million tons from the Persian Gulf."

SCOTTISH BRANCH

The Annual General Meeting of the Scottish Branch of the Institute was held at North British Station Hotel, Edinburgh, on January 8, 1948, the chairman, Mr Robert Crichton, presiding.

Summarizing the past year's activities, the chairman said that there had been six ordinary meetings at which lectures had been given by specialists in the particular field covered. In particular he would mention the visit of Mr R. Price Russell, the 1947 Cadman Memorial Medallist, when an audience of over 200 had seen something new in lecture technique, as least new as far as Britain was concerned.

In July forty members had participated in a visit to Comrie Colliery. They were indebted to Dr Reid for arranging the outing and to the National Coal Board for their courtesy in permitting the visit and in providing luncheon.

It was the aim of the Committee, said Mr Crichton, to arrange lectures of interest to members and he took the opportunity of mentioning that in 1950 there would be the James Young Centenary Celebrations. Concurrently with these would be the Second International Conference on Oil Shale and Cannel Coal.

Membership now stood at a total of 95.

The following officers were re-elected: Robert Crichton (*chairman*); J. T. Guthrie (*deputy chairman*); Dr G. H. Smith (*hon. treasurer*); A. Fleming (*hon. recorder*); W. Robert Guy (*hon. secretary*); George Grant and Dr W. B. Pentherer (*hon. auditors*). The retiring members of the committee, J. M. Caldwell and Prof W. M. Cumming, were re-elected; other members of the committee are: J. A. Brown, H. McArthur, H. Peden, and Dr William Reid.

RETIREMENT OF R. I. LEWIS

R. I. Lewis, B.Sc., Fellow of this Institute, who retired from the position of manager of the Sales Technical Advisory Department of Shell Petroleum Company at the end of January, has been associated with the Royal Dutch-Shell Group for nearly 25 years. Much of this time he spent in the United States, first in the refinery at Wilmington and later in the Sales and Special Products Departments in New York. For the last eight years he held the post from which he has just retired.

A pleasant ceremony took place recently in London when his colleagues presented him with a token of the esteem in which he is held, and wished him every happiness in his retirement, a wish in which we heartily join. We understand that his colleagues in the Royal Dutch Group are shortly to make a similar presentation, and that a parting gift from his former colleagues in the U.S.A. is en route.

Mr Lewis, after being chairman of the Hydrocarbon Research Group of this Institute for some time, was chairman of the Research Committee until recently. He served also for some time as a member of Branches Committee, and as member and Registrar of Election Committee, as well as being a Member of Council of the Institute since 1945.

COST ACCOUNTING IN PETROLEUM REFINERIES

By W. S. THOMPSON, C.A.*

AN important factor in the management of an oil refinery is the efficiency with which the various process plants are operated, as on this efficiency will depend the profitability of the refinery. In the efficiency of the operation, the question of the costs plays an important part and it is, therefore, essential that these costs should be both accurate and also presented as soon as possible after the end of the period to which they relate. The purpose of this article is to give a simple outline of the day to day work leading to the production of the final costs.

Expenditure in petroleum refineries falls into two classes. Firstly that which can be allocated to a particular operation at the time when the expenditure is incurred; examples of this type of expenditure are salaries and wages, operating and maintenance materials, repairs to plants by outside contractors, etc. The second class consists of items which cannot be allocated to a particular operation and examples of this are postages, subscriptions, telephones, etc. Both classes of expenditure are recorded in total in the financial accounts of the refinery and in addition the expenditure in the first class is analysed in subsidiary accounts.

The basis of the analysis to the subsidiary accounts just mentioned will now be considered and as examples, wages and material issues will be dealt with. For each workman a time sheet is prepared covering a week's work. On that sheet are shown the number of hours worked on each job and the total wage is split over the jobs according to the number of hours worked. It is suggested that the total wage should represent the cost to the company and should, therefore, include the gross wage (before deduction for Income Tax, etc) and all contributions payable by the company such as state insurance, superannuation schemes, and provident funds. When the time sheets for all the workmen have been dealt with in this manner, an analysis is prepared giving the total wages allocated to each job. The total of that analysis, which will be entered in the subsidiary accounts, must, of course, agree with the total of the wages charged to the "Wages Account" in the financial accounts.

The operation and maintenance of refinery plants necessitates the use of various types of materials. Stocks of such materials are, as a rule, kept at the refinery, as otherwise its running might be seriously delayed if the required materials had to be obtained from outside stockists. When materials are required, a request is sent to the Materials Department who issue what is called for. Each day or period, the Materials Department prepare a list showing values of the issues made to each job, as shown on the request sheets received by them. The value used in pricing these sheets is taken from the stock cards kept by the Materials Department. An analysis of these daily or other periodic lists is kept by the Accounts Department and each month the total for each job is entered in the appropriate accounts in the subsidiary accounts. At the same time the total of all issues during the month is entered in the "Materials Consumed Account" in the financial accounts.

From what has been written about the analysing of wages and materials,

* Chief Accountant, "Shell" Refining and Marketing Co. Ltd.

the entering of the analyses in detail in the subsidiary accounts, the entering of the wages and materials issues in total in the financial accounts, it will be evident that control can be exercised insofar as the arithmetical accuracy of the subsidiary accounts is concerned. It is equally important to ensure that the job incurring the expenditure is charged with the outlay. This aspect of the problem is one which depends on all departments, as mis-allocation of wages or materials by the chemist, engineer or plant operator means errors in the final costs just as great as mistakes by the accountant in charging the wrong account would mean.

As the normal period for preparation of refinery costs is six-monthly or even yearly, some steps must be taken to give a safeguard against mistakes such as those just mentioned and the following suggested method should ensure any major errors being discovered within a few weeks of their being made. Each month the refinery superintendent should be advised of the operating and maintenance wages and materials spent on each plant and the chief engineer should be advised of the maintenance wages and materials for each plant and also the wages and materials for operating and maintenance of the steam boilers, electric generators, air compressors, etc. By a careful study of this monthly return, any major errors in allocations should be brought to light.

In addition to showing the operating and maintenance wages and materials on the monthly return submitted to the refinery manager, it is suggested that certain other data should also be given. For example, the consumption of steam in tons and electricity in units could be shown as, with this information and knowing the plant intake, the refinery manager can see if these utilities are being used economically or whether there is scope for effecting economies.

During the period for which costs will be prepared, as much work as possible in the building up of data should be done so that at the end of the period no time will be wasted in commencing the work involved in compiling the costs. For example, cumulative totals should be kept month by month of consumption by the various plants of such items as steam, electricity, compressed air, own fuel, etc. As regards fuel, it may be that this is purchased from outside sources, in which case no difficulty will be experienced in getting a value for charging in the costs, but if the fuel used in the refinery is the refiners own property, the consumption may be shown in quantities only or some appropriate value may be placed on the fuel for inclusion in the costs statements.

A date should be set after which no further items of expense affecting the period involved will be taken up and in the event of any known items for which accounts have not been received by that date, an estimate of the amount involved will have to be made and taken up in the accounts. A statement can then be prepared showing the total expenditure which has to be included in the costs statements. This statement should show the expenses under headings, such as salaries and wages, materials consumed, repairs to buildings and plant, telephones, postages, insurances, rates and rent, etc, etc, and it is suggested that comparative figures for the previous period should be shown.

As has already been stated, certain of these accounts have already been analysed in subsidiary accounts and at the close of the period the remaining accounts should be allocated to the appropriate account in the Subsidiary Accounts. For example, fire insurance should be charged to each building or plant in the ratio of the value of the particular building or plant. In some cases the allocation will be to an "overhead" account (a definition of this term is given later), the total of which will

have to be allocated over the costs statements on some reasonable basis.

When the work outlined above has been completed, the stage has been reached when the preparation of the "Process Costs" can begin. In these costs there are several types of expenditure and these are:

1. Direct costs;
2. Utilities and services;
3. Fixed charges and overheads;
4. Depreciation.

1. *Direct Costs*

These may be defined as items which would cease in the event of any process being discontinued and will consist of operating wages and materials, maintenance wages and materials, repairs by outside firms, chemicals, and fuel. The expenditure for the period for these items is already available from the Subsidiary Accounts and can be entered into the costs statements without any further work or adjustment being needed.

2. *Utilities and Services*

These will include: (*a*) Steam boilers; (*b*) Electricity; (*c*) Compressed air; (*d*) Water; (*e*) Pumphouses; (*f*) Laboratory; (*g*) Locomotives.

Costs statements should be prepared for each of these and the statements would show firstly the "Direct Costs" as outlined above. To these would be added "Fixed Charges and Overheads" and "Depreciation", giving a total cost for each utility. These costs would then be allocated over the "Process Costs" on the basis of the usage by each process.

3. *Fixed Charges and Overheads*

These may be defined as expenses which will continue for some time even if all or part of the refinery is shut down.

(*a*) Fixed Charges will include items such as fire insurance, rates and rent, etc. These can be allocated to the "Process Costs" and "Utilities" on the basis of capital values as regards fire insurance and on the basis of the area covered by the various buildings and plants as regards rent.

(*b*) Overheads will include the following: (i) General refinery supervision; (ii) Accounts department expenses; (iii) Oil stocks department expenses; (iv) Labour department expenses; (v) Materials department expenses; (vi) Medical department expenses.

Some arbitrary basis will have to be used in order to allocate these expenses over the processes and utilities. Insofar as items (i), (ii), (iv) and (vi) are concerned, the method adopted could be to split up these accounts on the ratio of the operating and maintenance labour in each process and utility to the total operating and maintenance labour of all processes and utilities. Item (iii) could be split on the basis of the tonnage of the various grades of oil treated, while item (v) could be split on the ratio of the value of the operating and maintenance materials issued to each process and utility to the total value of operating and maintenance materials issued. It could be argued that, as regards allocating Materials Department expenses, the weights and or volume of the issues should be taken into account as well as the value, the reason being that a process which may use expensive materials requiring little handling will take too large a share of the expenses compared with a process which may use inexpensive but heavy or bulky materials requiring a great deal of handling. It is thought, however, that the extra work and expense involved in keeping the necessary records would not justify the work being done.

4. *Depreciation*

This will be made up of Depreciation on the following items: (*a*) The assets

used in each process plant; (*b*) The assets used in the various utilities; (*c*) The assets used in the general services of the refinery such as machine shop equipment, motor transport, office machines, etc.

The depreciation on the general services assets will be allocated to the Process Costs and Utilities costs on some arbitrary basis. The depreciation on the utilities assets, plus the proportion of the depreciation on the General Services Assets will then be allocated to the process costs on the basis of usage by each process.

As a result of carrying out the work outlined, all expenditure will have been collected in the process costs and the total of all these costs should agree with the total of the statement mentioned in paragraph nine.

Consideration can now be given to the form in which the Process Costs should be set out. It is suggested that the statements should show at the top the quantity of intake to the plant for the current and previous periods. The expenditure should be shown to the nearest £ for the current and previous period and, in addition, the expenditure per ton of intake should be shown for both periods. The expenditure should be set out under the various classifications already dealt with in detail, i.e.

Direct costs;

Utilities and services direct costs;

Fixed charges and overheads—

(*a*) Directly allocated to the process;

(*b*) From utilities and services;

Depreciation—

(*a*) On the process plant assets;

(*b*) On the utilities assets;

(*c*) On general services assets.

In addition to showing these details on the statements it is also suggested that, at the foot of the statements, there be shown the quantities of the various grades of fuel consumed, either directly on the plant or indirectly in the utilities. There should also be shown the quantities, and the quantity per ton of intake, of the utilities consumed in the process. These figures should be given both for the current and previous periods.

Costs statements should also be prepared for the utilities, the information shown being similar to that in the process costs. It is suggested that, in support of each of the utilities costs statements, there be given a schedule of the quantities used by the various processes for the current and previous periods. In the event of there being any large fluctuation in the quantity consumed of any utility, this schedule would show the process or processes responsible for the fluctuation.

When the process costs statements have been completed these will enable comparisons to be made with previous periods for the refinery in question. They will also enable comparisons to be made with other refineries, but when making these comparisons allowance must be made for differences in the operating conditions either between different periods for the refinery in question or between two refineries. For example, when comparing costs for refineries in different countries, allowance would have to be made for variations in the conditions of labour in the two countries.

In conclusion, it is suggested that the accounts staff who are engaged in the preparation of the costs statements should be given every opportunity to familiarize themselves with the different processes by having these explained to them on the site during the actual operating of each process by the chemist in charge. Without the knowledge of the broad outline of each process, it would not be possible for the accounts staff to take their proper share in any discussions on the operating of the refinery.

GASIFICATION OF SOLID FUELS

By L. A. MOIGNARD*

THE dependence of modern life upon petroleum products has combined with geographical, political, and economic considerations to render the question of supply of immense importance to all developed civilizations. Those countries which have not within their borders, or do not securely control outside them, ample natural deposits, labour under grave disadvantages, in peace and war. These disadvantages can be minimized, as they were in Germany before and during the war, by the establishment of a synthetic petroleum industry, which was made possible by advances in methods of gasifying solid fuels and in the technique of chemical synthesis.

The manufacture of gas from solid fuel is, of course, far older than petroleum technology itself, and has important applications in many industrial fields. The knowledge so secured was invaluable in enabling the special requirements of a synthetic oil process to be satisfied.

The essential gasification reactions for solid fuel are between carbon on the one hand and steam or oxygen on the other:

$$C + H_2O \rightarrow CO + H_2$$
$$C + \tfrac{1}{2}O_2 \rightarrow CO$$

The first reaction is the one which is widely used for producing "water gas" ("blue" water gas is essentially a mixture of carbon monoxide and hydrogen), while the second is the basis of the manufacture of "producer gas" (which consists principally of about one part by volume of carbon monoxide with two parts of nitrogen from the air used). The reaction between carbon and steam is "endothermic" (i.e., heat must be supplied to enable the reaction to proceed) to the extent of 31,192 calories per gram molecule, while the combustion of carbon to carbon monoxide is exothermic and gives out 26,617 gram-calories for each 12 grams of carbon burned. Producer gas is generated in industry by reacting the solid fuel with a mixture of air and steam; the amount of steam which can be introduced being limited by the fact that the reaction of carbon with steam absorbs heat and by the necessity for maintaining the fuel bed temperature. The producer gas so obtained contains a proportion of water gas (i.e., of carbon monoxide and hydrogen) and has a higher calorific value than when steam is not used. The reaction is, with proper adjustment, thermally self-supporting and continuous, and requires no supply of heat after the reaction has once started. The combustible gas is, however, heavily diluted with nitrogen and the use of producer gas is generally limited to circumstances in which a very large quantity of cheap gaseous fuel is required and can be consumed near the point of generation, often while it is still hot.

While employing combustion in air for maintaining the fuel bed temperature, dilution of the product with nitrogen can be avoided by supplying the steam and air alternately. This is the principle of the normal water-gas generator; in a short cycle, in which the valve-changing operations are commonly mechanized, the fuel bed temperature is first raised by "blowing" with air, and then water-gas is made by "steaming", accompanied by a falling temperature.

In Britain water-gas manufacture occupies an important place on gas works. Normal carbonization of bituminous coal produces coke and gas in a ratio which is undesirably inflexible,

* The Gas Research Board.

having regard to the demands for these products. Water-gas manufacture, with the gasification of a proportion of the coke, enables this ratio to be controlled. The calorific value of water gas (about 300 B.Th.U cu. ft.) is, however, considerably lower than that of normal town's gas, and it is usual to enrich it by "carburetting", i.e., by the gasification of a petroleum oil fraction (gas oil) in chambers, placed immediately after the generator, which are heated during the "blow" period by combustion of the weak producer gas then generated.

Methods are available for enabling gasification to be continuous while avoiding extensive dilution with nitrogen. One is to provide external heating of the generator; another, which was suggested by Cobb and Hodsman in England in 1920, has found wider application. Instead of air, oxygen, obtained by fractionation, is used.

Economic and technical considerations alike led to rapid developments in gasification with oxygen in Germany, before and during the war. German political objectives enforced a policy of domestic liquid fuel production, which could only be satisfied with a large supply of gas either for hydrogenation or for synthesis by the Fischer-Tropsch process. The country enjoys an abundant supply of brown coal, which, either as such, or after carbonization, is very amenable to gasification. It is highly reactive and, being non-coking, can be fed directly to generators without difficulty arising due to agglomeration.

A large and complex industry grew up near Leipzig, based on local brown coal, in which petroleum was produced by the hydrogenation of the tar derived from low-temperature carbonization of brown coal. The solid residue, called "grude", was employed in Winkler generators for the production of water gas from which the hydrogen was obtained.

A typical Winkler generator is a cylindrical vessel, in which carefully premixed oxygen and steam are supplied to the fuel bed from below, a secondary stream entering higher up. A unit of diameter 8 to 9 feet will consume up to 40 tons of fuel per hour, and produce 48,000 cu. ft. of gas per ton. It is of interest that the plant embodies an early stage in the development of a technique which is now attracting much attention. The fuel bed in the generator is "boiling"; that is, the pieces of fuel are so small (0-5 mm), and the gas velocities so large, that the bed is lifted from the grate and maintained in violent turbulent motion, very like a boiling liquid. This motion affords a means of transferring heat from near the oxygen inlet by convection to the upper regions of the bed where the reaction with steam can continue. "Fluidization", which has been introduced into the catalytic cracking branch of petroleum technology, employs this principle, with the development that bodily transfer of catalyst from one portion of the plant to another is effected in the gas stream. The dust, which is inevitably present in the effluent gas, is carried forward and is recovered in cyclones and electrostatic precipitators. Because it contains much gasifiable material, carbon utilization efficiencies ranging between 90 and only 60 per cent have been reported. The dust can, however, be consumed in steam-raising. The Winkler technique is limited in its applicability to a cheap fuel, on account of the cost of oxygen.

The gasification of carbon in steam leads on the simplest assumption to a mixture of hydrogen and carbon monoxide in equal volumes. Where it is found necessary to raise the proportion of hydrogen present, either for hydrogenation or for Fischer-Tropsch synthesis, a number of methods are available. Some hydrogen is derived from the fuel itself, and in the water-gas generator an excess of hydrogen and some carbon dioxide (which can be comparatively readily removed) arise from the reaction $CO + H_2O \rightarrow CO_2 + H_2$.

This reaction can be employed either during gasification, or subsequently. Where it forms a subsequent stage, it is commonly carried out catalytically, over various varieties of iron oxide; the use of molybdenum sulphide has been suggested, since this is less readily poisoned, i.e., its activity is not so easily reduced by traces of impurities. The conversion temperature can then be comparatively low (400° to 500° C) when a high yield of hydrogen is favoured by equilibrium considerations.

Alternatively, the gasification can be carried out using a large excess of steam and, in the Lurgi generator, this is carried out working at a pressure of several atmospheres. A high rate of gasification can be maintained, and the plant can be used both with brown coal and hard, non-coking coals. Operation under pressure enables carbon dioxide removal to be effected by washing with water; the plant and auxiliary purification equipment is small and compact, and no compression is required for subsequent synthesis.

The newer gasification methods have been considered in this country as a means of town's gas production. The standard carbonization methods rely upon particular types of coal, and have the limitation that the gas-coke ratio is capable of far less adjustment than the market demands. Though the water-gas generator can be used to redress the balance, the maintenance of a high calorific value depends upon gasifying imported oil to provide additional hydrocarbons. There is thus an arguable case for developing a method for manufacturing town's gas from British coals without producing coke or consuming oil, such a method being usable alongside the classical gas-production plant. It is borne in mind that these prospects depend upon manufacturing oxygen sufficiently cheaply.

It has been indicated that the Lurgi technique offers particular promise in this direction. When conditions are suitably chosen, it can produce gas containing sufficient methane to have a calorific value approaching that favoured for town's gas distribution in Britain. Pressure gasification without coke production offers advantages also, when large-scale generation with long-distance transmission is under review, and there is the possibility that it would be applicable most advantageously to weakly-caking coals, thereby widening the choice of coal available to the gas industry. The Gas Research Board have for some years been investigating many aspects of the question.

The author is indebted to the Director and Council of the Gas Research Board for permission to publish this paper.

THE LIBRARY

Members of the Institute are invited to express their views as to books which they consider should be obtained for the Library, and are asked to furnish full particulars of such books to the secretary.

Missing Periodicals

The Library of the Institute is missing the following periodicals:

Industrial & Engineering Chemistry, Analytical Edition. October 1945.

Chemical & Metallurgical Engineering. May 1944.

National Petroleum News. October 8, 1941; January 28, February 25, 1942.

National Petroleum News, Technical Section. January to June and December, 1942.

Oil Weekly. All 1944.

Petroleum Engineer. June 1944; March 1945; June 1946.

Geophysics. January 1944.

If any member has any of the above to spare the librarian would be glad to have them in order to complete the files.

OIL FOR GRASS DRYING

In a paper on "Grass Drying on the Farm" read on November 26, 1947, before the Institution of British Agricultural Engineers, Mr W. Newcome-Baker said:

"During the last three seasons the drying plants have been operated with oil as fuel, which on the whole has proved most satisfying and reliable; but there is room for much research in the design of furnaces for this fuel.

"A furnace designed for the most economical use of fuel oil has yet to be seen. They are usually of a type designed for coke, adapted to take an oil burner and can never be really successful or economical.

"The fuel oil is brought to the farm by the supplier, no labour is required to operate, and the cleanliness and thermostatic control make for the utmost efficiency. With oil firing in conjunction with a flow meter and thermograph, very exact figures can be arrived at."

Dealing with the question of fuel consumption the author said that although the figure was higher than for coke, the economy is more marked when the whole picture is considered. Of the total cost of drying, fuel oil is stated to account for 21 per cent in terms of cost per ton of meal produced.

On the subject of "Grass Drying Plants" Mr C. B. Chartres, at the same meeting, said:

"The fuels most commonly used are coal, coke, or oil. It is a great advantage to have automatic stoking coupled with thermostatic control of the temperatures of the hot gases. This can be most easily effected with oil fuel, but in certain parts of the country coal and coke can be obtained at prices which offer considerable economy compared to oil, and in these cases solid fuel will continue to be used."

JAMES YOUNG MEMORIAL LECTURE

At the meeting of the Scottish Branch of the Institute held on January 8 the first James Young Memorial Lecture was delivered by Mr Edwin M. Bailey.

The chairman, Mr Robert Crichton, particularly welcomed among the audience of about one hundred the presence of Miss Thom of Limefield, Mrs Caw, and Mr John Young, grandchildren of Dr James Young, and Miss Caw, great-granddaughter.

Welcoming Mr Bailey, the chairman said he needed no introduction and he thought it was very brave of him, at his advanced age, to offer to lecture at all. He had, however, made a close study of the life and work of Dr Young. Trained in the Department of Technical Chemistry endowed by Dr Young, Mr Bailey had, at the time of his retriement in 1936, been closely connected with the Scottish shale oil industry for fifty years. For 42 years he had been chief chemist to the Pumpherston Oil Co. Ltd., and to Scottish Oils Ltd. He had experienced many ups and downs in the industry but, due no doubt to his determined Scottish spirit, had never lost faith.

Before calling upon Mr Bailey to deliver his address, Mr Crichton said he would like to mention that Mr Bailey had other interests in life than chemistry. His life-long interest in Dr Barnardo's Homes was well known, and it was no secret that as an expert conjuror he had delighted many with his tricks and patter.

Upon the conclusion of the lecture, which we hope to reproduce later, a film was shown depicting scenes from the life of Dr Young and developments in the Scottish mineral oil industry.

A vote of thanks to the lecturer was proposed by Prof W. M. Cumming and to the chairman by Mr J. J. Crombie.

NICKEL IN THE PETROLEUM INDUSTRY

Three bulletins dealing with the application of nickel, nickel alloys, and nickel-containing materials in the petroleum industry have been issued by The International Nickel Co. Inc., and copies are available to interested persons on application to The Mond Nickel Co. Ltd., Development and Research Dept., Grosvenor House, Park Lane, London, W.1.

The three bulletins are:

Monel, Nickel and Inconel in Oil Refining

The relative extensive application of nickel and nickel alloys in oil refinery processing is outlined by illustrated reference to specific service uses in distillation, catalytic processes, treating, lube plants and miscellaneous applications. The technical considerations on which the selection of these materials are based are also given in the text.

Data are also provided on the engineering properties of Monel, K Monel, Inconel and nickel, with brief notes on the fabrication of these materials.

Alloyed Cast Irons in Petroleum Refining Equipment

The engineering properties of various alloyed cast irons in relation to typical petroleum refinery equipment applications are given, with guidance on the selection of suitable alloyed cast iron compositions to provide the desired combination of properties. A useful tabular survey of typical applications is also provided, cross-referenced to the relevant portions of the text where the metallurgical characteristics and properties of various alloyed cast irons are discussed.

Nickel Alloy Steels in Petroleum Production Equipment

The scope of this publication is indicated in the first two paragraphs, which read as follows:

"The steels used in modern oil production equipment must provide dependable performance under widely varying conditions of service. Combinations of high static and dynamic stresses involving fatigue, impact, shear or bending are often encountered simultaneously even under normal conditions; and when emergencies arise, their severity may be increased several-fold.

"The nickel alloy steels, through their ability to meet these unusual requirements, have gained an excellent reputation in this field. Their toughness at extreme hardness, and their ability to resist high fatigue and impact stresses, under conditions which often involve severe overstressing, have characterized them as being well fitted for the gruelling service encountered in the oilfields. Some of these steels and their typical applications are described in the following paragraphs."

New work recently started by the *British Standards Institution* includes that in domestic oil burning appliances, rolled asphalt (gravel aggregate), and bitumen macadam (gravel aggregate). When draft specifications are available a further announcement will be made.

Post-graduate lectures on Physics at the Acton Technical College include a course of four lectures by Dr R. C. Brown on *Recent Developments in Surface Tension* (March 3, 10, 17 and 24) and by Dr C. H.Carlisle on *X-Rays and the Study of Carbon Compounds* (April 14, 21, 28, and May 5). Each lecture commences at 7.30 p.m. The fee for each series is 10s, and registration form is obtainable from the Principal, Acton Technical College, High Street, Acton, W.3.

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FORTHCOMING MEETINGS

INSTITUTE MEETINGS

The Production of Oil from the Fields of South-west Iran. H. S. Gibson. At 26 Portland Place, London, W.1, 5.30 p.m. (Tea, 5 p.m.), March 10.

Properties of Paraffin Wax as an Effect of Composition. S. T. Minchin. At 26 Portland Place, London, W.1, 5.30 p.m. (Tea, 5 p.m.), April 14.

The Chemical Evaluation of Oils of Medium Viscosity. C. H. Johnson. At 26 Portland Place, London, W.1, 5.30 p.m. (Tea, 5 p.m.), May 12.

NORTHERN BRANCH

The Fighting of Oil Fires. E. Thornton. At Engineers' Club, Manchester, 6 p.m., March 8.

Some Aspects of Modern Automotive Design and Development. C. L. Goodacre. At Engineers' Club, Manchester, 6 p.m., April 12.

Annual General Meeting. At Engineers' Club, Manchester, May 10.

SCOTTISH BRANCH

The Oilfields of Iran. F. D. S. Richardson. At North British Station Hotel, Edinburgh, 7.30 p.m., March 26.

MEETINGS OF OTHER SOCIETIES

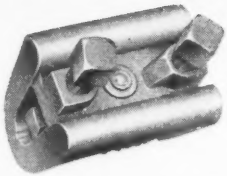
The Trade and Technical Press. R. E. Dangerfield. Royal Society of Arts, London, 2.30 p.m., March 10.

Heat Transfer. A. D. Davidson. Society of Chemical Industry, at Geological Society, London, 5.30 p.m., March 16.

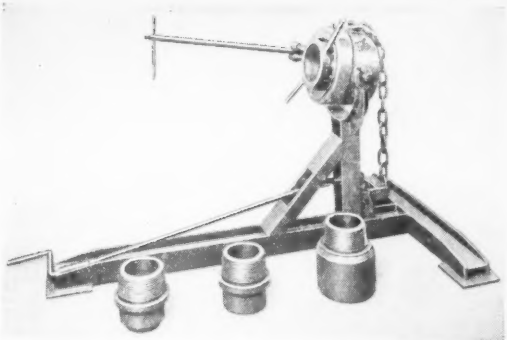
Chemicals from Petroleum. K. Gordon. The Royal Institute of Chemistry (Teesside Sect.), March 18.

Value of Statistics to the Chemical Engineer. N. T. Gridgeman. Institution of Chemical Engineers, at College of Technology, Manchester, 3 p.m., March 20.

Automatic Control Applications in the Chemical Industry. H. Schmitt. Society of Instrument Technology, at College of Technology, Manchester, 7.15 p.m., April 13.



TWO BOLT POLISHED ROD GRIP



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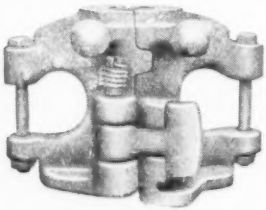
HANDLE TYPE POLISHED ROD SPACING CLAMP



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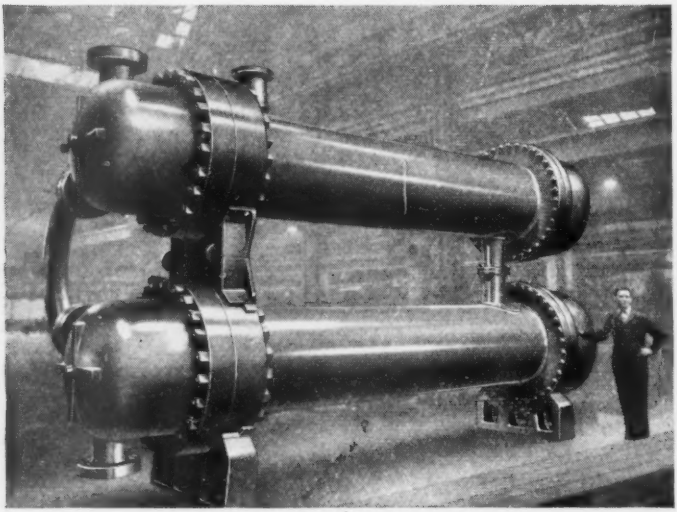

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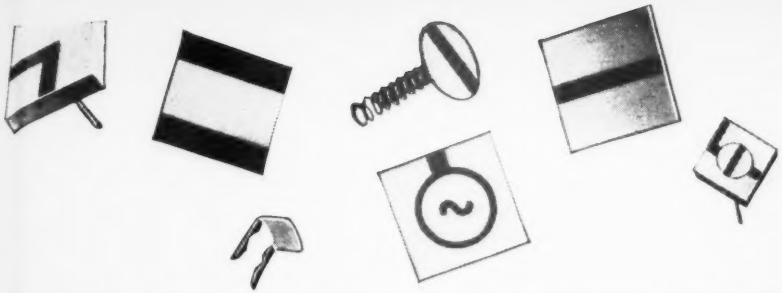

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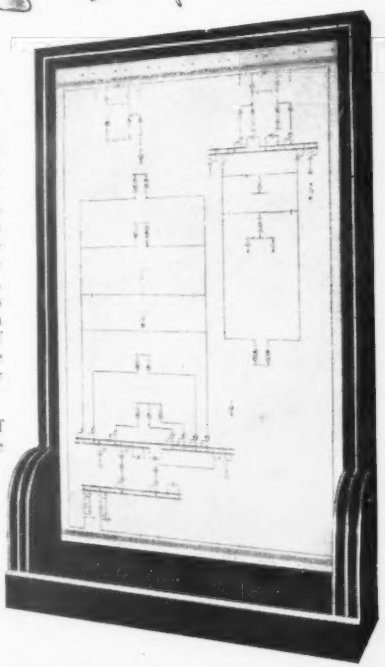
A complete pictorial record of electrical connections throughout an area can be built up and periodically adjusted to show any changes by means of the mosaic diagrams used with Supervisory Remote Indication and Control Equipment. These diagrams consist of small square pieces of plastic material with electrical line connections or apparatus symbols depicted on their surface. They are mounted on pierced mounting strips by means of simple clips and any required representation of electrical connections can thus be built up to suit the circumstances. Where necessary the circular centre portion of the moulded squares can be rotated so that, for example, the state of connections of circuit breakers and isolators can be shown. Should changes occur such as the addition of new stations or the re-arrangement of feeders, the appropriate section of the diagram can be revised quickly and conveniently to suit the new conditions.

These ingenious wall diagrams are but one example of the many ways in which A.T.M. Supervisory Remote Indication and Control Equipment can be applied to the needs of industrial, commercial or public utility establishments.



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